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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1 , 2015/2016

ERT3026 - AUTOMATION
(RE)

12 OCTOBER 2015
9:00 a.m – 11:00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This Question paper consists of **5 pages** including cover page with **5 Questions** only.
2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

Question 1

A simple load cell, as shown in **Figure Q1 (a)**, consists of an aluminum post of 0.025 m radius with a detector and compensation strain gages.

The $140\ \Omega$ strain gauges are used in the bridge of **Figure Q1(b)** with $V = 4\text{V}$, $R_1 = R_2 = R_D = 140\ \Omega$, *Gage Factor* = 2.13 and modulus of elasticity for aluminum = $6.89 \times 10^{10}\text{ N/m}^2$.

Determine:

- (a) The change of resistance, ΔR [12 marks]
- (b) Resistance with post under compression [2 marks]
- (c) Variation of bridge offset, ΔV , for load of 0 to 22240 N. [6 marks]

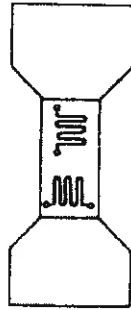


Figure Q1(a)

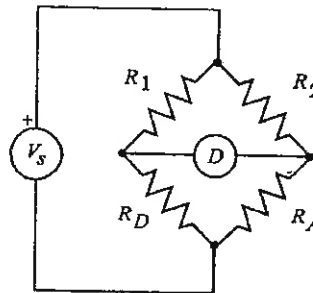


Figure Q1(b)

Question 2

- (a) A double acting hydraulic cylinder is to be used to move a work piece in a manufacturing operation. The relief valve setting is $70 \times 10^5\text{ N}$. The piston area is 0.016 m^2 and the rod area is 0.0045 m^2 . If the pump flow is $0.0013\text{ m}^3/\text{s}$, find the cylinder speed and load-carrying capacity for the
 - (i) Extending stroke. [6 marks]
 - (ii) Retracting stroke. [6 marks]
- (b) A DC servomotor is directly coupled to a blower shaft for an industrial process with the 24V supply voltage. The motor has a torque constant of 0.09 N-m/A . A voltage constant is 0.12 V/(rad/sec) and the armature resistance is $1.9\ \Omega$. Determine:
 - (i) the stall torque of the motor [4 marks]
 - (ii) the maximum speed at a torque of zero [4 marks]

Continued...

Question 3

- (a) Write a programmable logic controller (PLC) ladder diagram to control forward and reverse running of the motor as shown in the **Figure Q3(a)** by using the Input/Output assignment as shown in **Table Q3(a)**

This is possible by using two switches forward switch (X0) and reverse switch (X1) and the operation condition as follows:

- The forward switch is pressed,
- After 1 second, contactor Y0 will be enable and the motor run forward.
- The reverse switch is pressed,
- After 2 second, contactor Y1 will be enable and the motor run reverse.
- Y0 and Y1 will be disabling and the motor will stop running.

[15 marks]

Table Q3-(a) The Input/Output Assignment for Question 3(a)

Input Address	Input Devices
0.00	Push Button Switch (X0)
0.01	Push Button Switch (X1)
0.02	Push Button Switch (X2)
T0000	Timer One (1 sec)
T0001	Timer Two (2 sec)
Output Address	Output Devices
2.00	Forward Running(Y0)
2.01	Reverse Running(Y1)

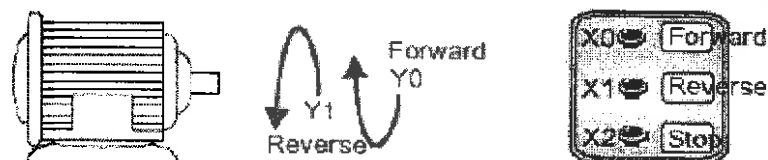


Figure Q3.(a): Motor for Question 3(a)

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Question 3

- (b) Analyze the system operation of the PLC ladder diagram as shown in the Figure Q3 (b). [5 marks]

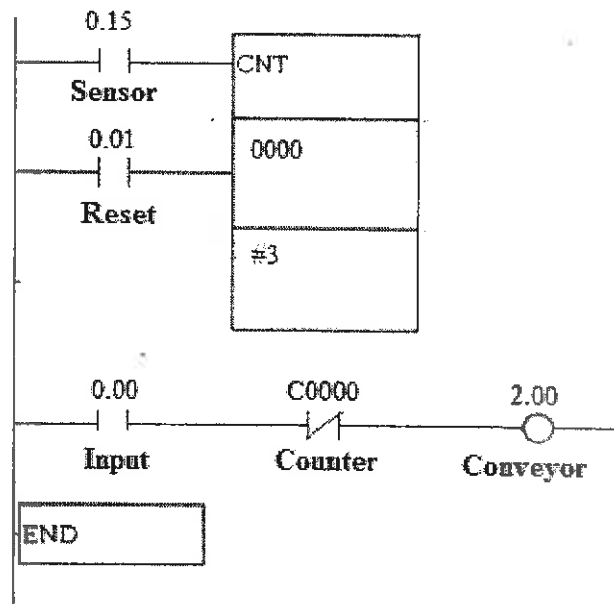


Figure Q3 (b) PLC Ladder Diagram for Question 3(b)

Question 4

A 20-stations in-line transfer machine has an ideal cycle time of 0.4 min. Station breakdowns occur with a probability $p = 0.01$. Assume those station breakdowns are the only reason for line stops. Average downtime = 0.7 min per line stop. Use the upper-bound approach to determine the following:

- | | | |
|-------|--------------------------------|-----------|
| (i) | Ideal production rate | [3 marks] |
| (ii) | Frequency of line stops | [3 marks] |
| (iii) | Average actual production rate | [8 marks] |
| (iv) | Proportion down time | [3 marks] |
| (v) | Line efficiency | [3 marks] |

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Question 5

A flexible machining system (FMS) is being planned that will consist of four workstations and a part handling system. Station 1 will be a load/unload station. Station 2 will consist of horizontal machining centers. Station 3 will consist of vertical machining centers. Station 4 will be an inspection station.

For the part mix that will be processed by the FMS, the workloads at the four stations are as follows:

$WL_1 = 8.0$ min, $WL_2 = 23.0$ min, $WL_3 = 17.0$ min, and $WL_4 = 10.5$ min. The workload of the part handling system $WL_5 = 9.0$ min.

The FMS will be operated 16 hours per day, 250 days per year. Maintenance will be performed during nonproduction hours, so uptime proportion (availability) is expected to be 97%. Annual production of the system will be 50,000 parts.

Determine:

- (a) The production rate. [4marks]
- (b) The number of machines (servers) of each type (station) required to satisfy production requirements. [6 marks]
- (c) The utilizations of each station in the system for the specified production requirements. [6 marks]
- (d) What is the maximum possible production rate of the system if the bottleneck station were to operate at 100% utilization? [4 marks]

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